US009312314B2

(12) **United States Patent**
Hente et al.

(10) **Patent No.: US 9,312,314 B2**
(45) **Date of Patent: Apr. 12, 2016**

(54) **LIGHT APPARATUS FOR GENERATING LIGHT**

(71) Applicant: **OLEDWORKS GMBH**, Aachen (DE)

(72) Inventors: **Dirk Hente**, Aachen (DE); **Holger Spahr**, Braunschweig (DE); **Sami Hamwi**, Braunschweig (DE); **Alexander Rohr**, Braunschweig (DE); **Wolfgang Kowalsky**, Braunschweig (DE); **Torsten Rabe**, Braunschweig (DE)

(73) Assignee: **Koninklijke Philips N.V.**, Eindhoven (NL)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/373,369**

(22) PCT Filed: **Jan. 18, 2013**

(86) PCT No.: **PCT/IB2013/050470**
§ 371 (c)(1),
(2) Date: **Jul. 21, 2014**

(87) PCT Pub. No.: **WO2013/114244**
PCT Pub. Date: **Aug. 8, 2013**

(65) **Prior Publication Data**

US 2014/0339530 A1 Nov. 20, 2014

Related U.S. Application Data

(60) Provisional application No. 61/593,887, filed on Feb. 2, 2012.

(51) **Int. Cl.**
H01L 27/32 (2006.01)
H01L 49/02 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01L 27/3225*** (2013.01); ***H01L 28/20*** (2013.01); ***H01L 28/40*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC . H01L 27/3225; H01L 51/56; H01L 51/5256; H01L 28/40; H01L 28/20
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,816,358 B2 * 11/2004 Kida et al. 361/540
7,319,599 B2 * 1/2008 Hirano et al. 361/763
(Continued)

FOREIGN PATENT DOCUMENTS

CN 101937285 A 1/2011
JP 2004342885 A 12/2004
(Continued)

OTHER PUBLICATIONS

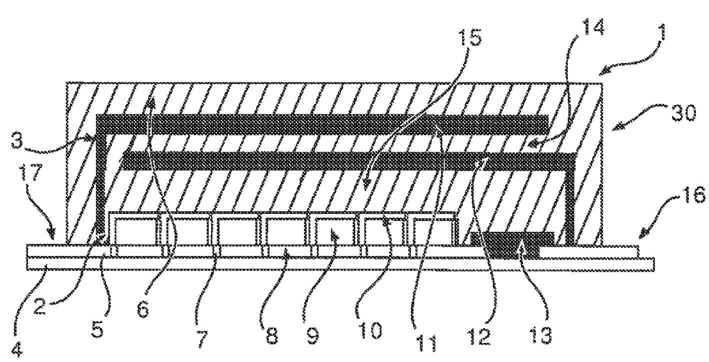
"High Density MIM Capacitors Using AL203 and AiTiOx Dielectrics" Chen et al, IEEE Electron Device Letters, vol. 23, No. 4, Apr. 2002 p. 185-187.
(Continued)

Primary Examiner — Ida M Soward

(57) **ABSTRACT**

The invention relates to a light apparatus (**1**) for generating light. The light apparatus includes a light emission structure (**2**) including light emission material (**9**), a capacitor structure (**3**) including at least two capacitor electrode films (**11**, **12**) and a dielectric film (**14**) between the capacitor electrode films, and a film encapsulation (**30**) including at least one film for encapsulating and thereby protecting at least the light emission material. The capacitor structure is integrated in the light apparatus such that the capacitor electrode films and the dielectric film are at least partly arranged in parallel to the light emission structure. Since films, in particular, thin films, are used for the capacitor structure and the encapsulation and since the capacitor structure is integrated in the light apparatus, the light apparatus can be relatively thin.

12 Claims, 8 Drawing Sheets



(51) **Int. Cl.**
H01L 51/52 (2006.01)
H01L 51/56 (2006.01)

(52) **U.S. Cl.**
CPC ***H01L51/5253*** (2013.01); ***H01L 51/5256*** (2013.01); ***H01L 51/56*** (2013.01); *H01L 27/3204* (2013.01); *H01L 51/5262* (2013.01); *H01L 2251/5361* (2013.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,749,161	B2 *	6/2014	Nerone et al.	315/291
2002/0060654	A1 *	5/2002	Park et al.	345/76
2009/0217521	A1	9/2009	Yang	
2010/0270924	A1	10/2010	Kaminska	
2011/0050604	A1	3/2011	Kwon et al.	
2011/0121723	A1 *	5/2011	Chen et al.	313/509
2011/0234097	A1 *	9/2011	Radermacher	315/53
2012/0098422	A1 *	4/2012	Jung et al.	313/512
2012/0146493	A1 *	6/2012	Ra	313/512

FOREIGN PATENT DOCUMENTS

KR	2009088286	A	8/2009
WO	2010125493	A1	11/2010

OTHER PUBLICATIONS

"Reliable Thin Film Encapuslation for Organic Light Emitting Diodes Grown by Low-Temperature Atomic Layer Deposition" Meyer et al, Applied Physics Letters 94, 2009.

* cited by examiner

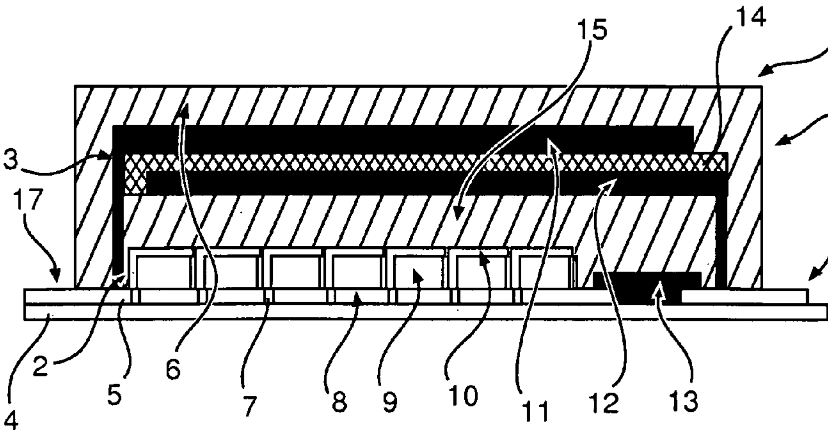


FIG. 1

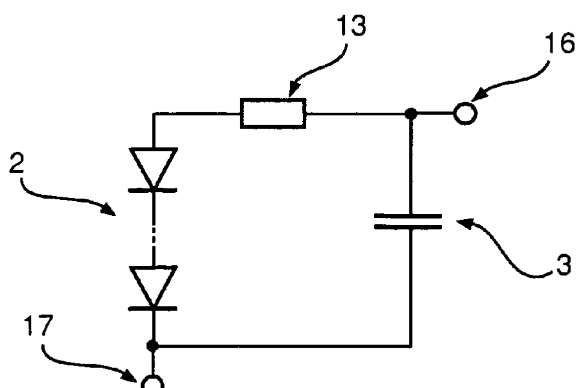


FIG. 2

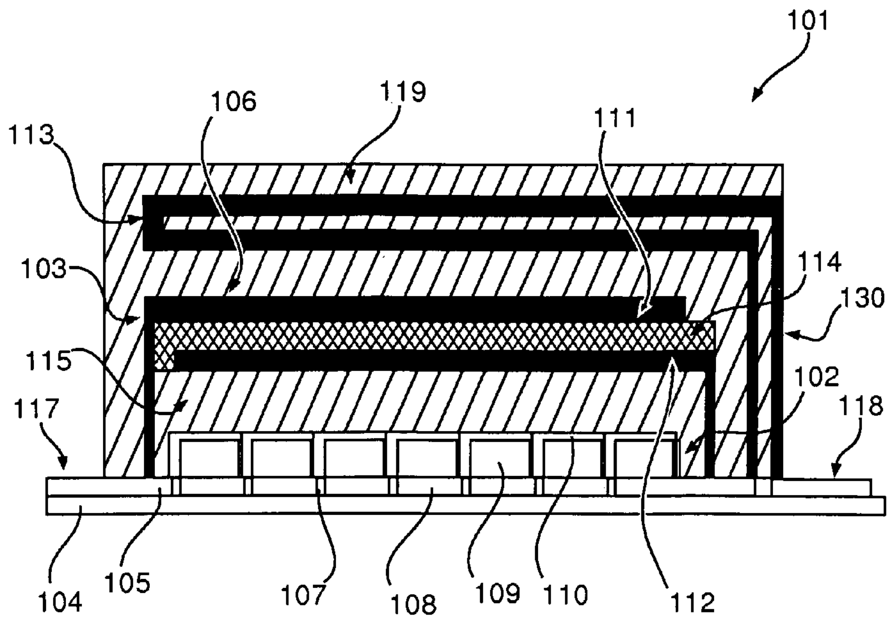

101
119
106
111
113
103
114
130
115
102
117
118
104
105
107
108
109
110
112

FIG. 3

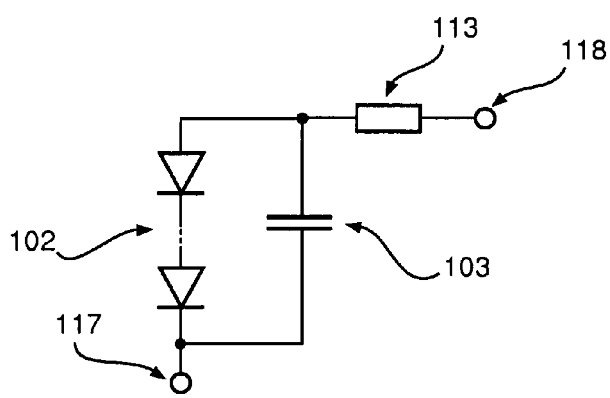

113
118
102
103
117

FIG. 4

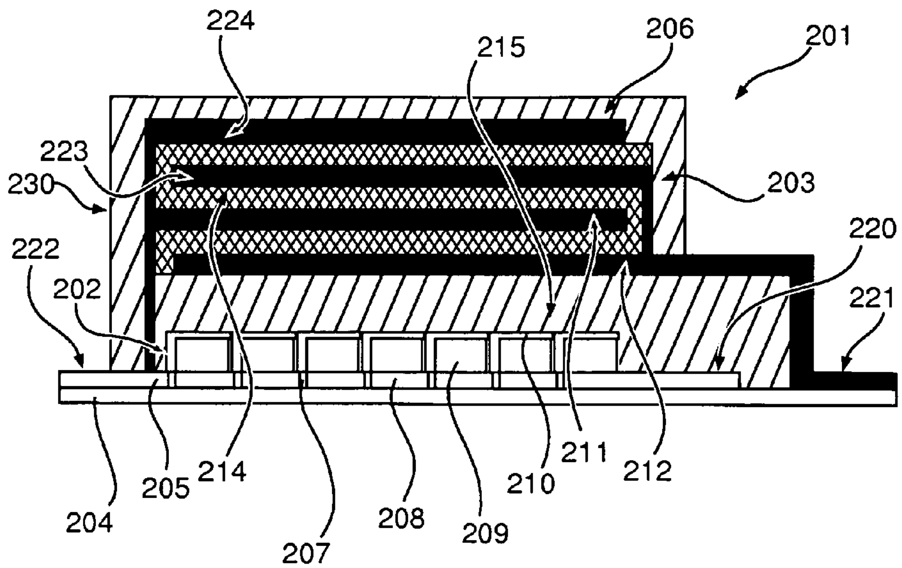

224
215
206
201
223
230
203
222
220
202
221
205
214
204
207
208
209
210
211
212

FIG. 5

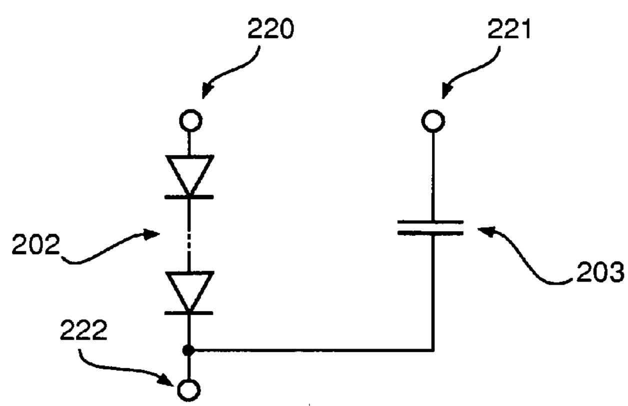

220
221
202
203
222

FIG. 6

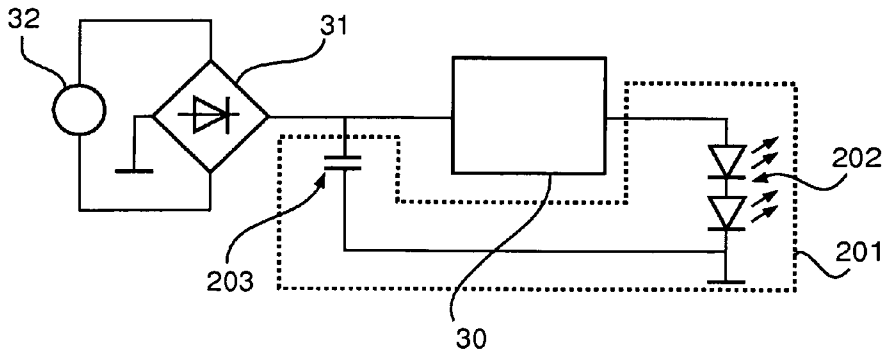


FIG. 7

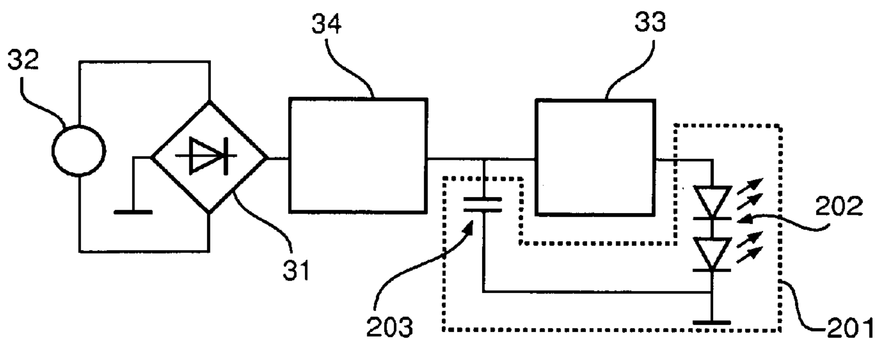


FIG. 8

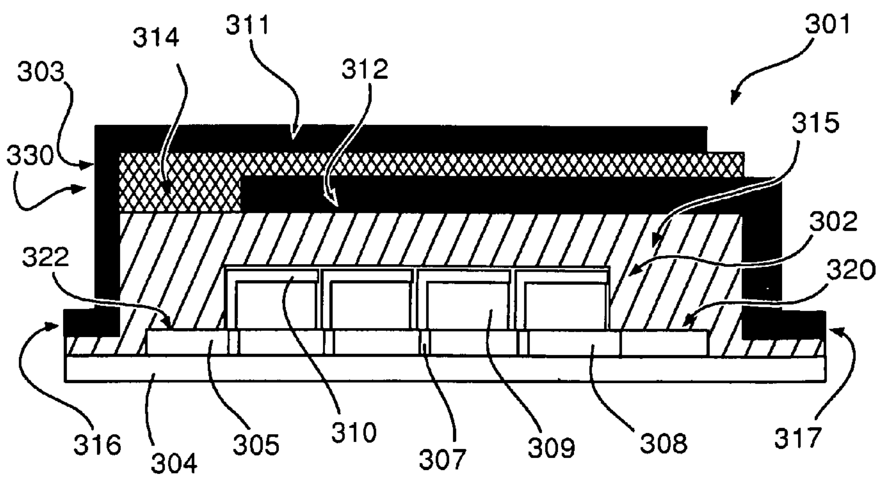


FIG. 9

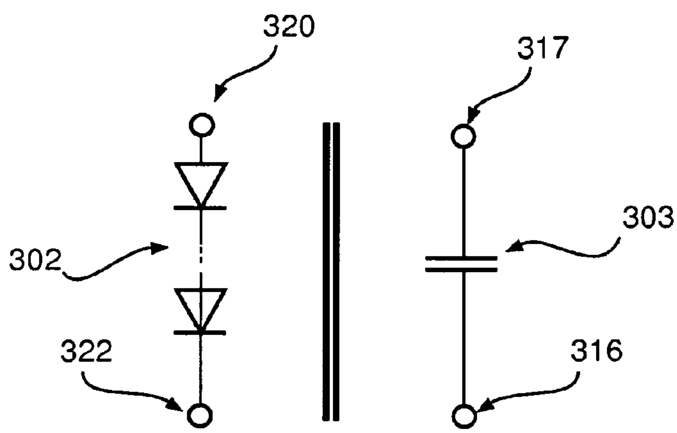

320
317
303
302
322
316

FIG. 10

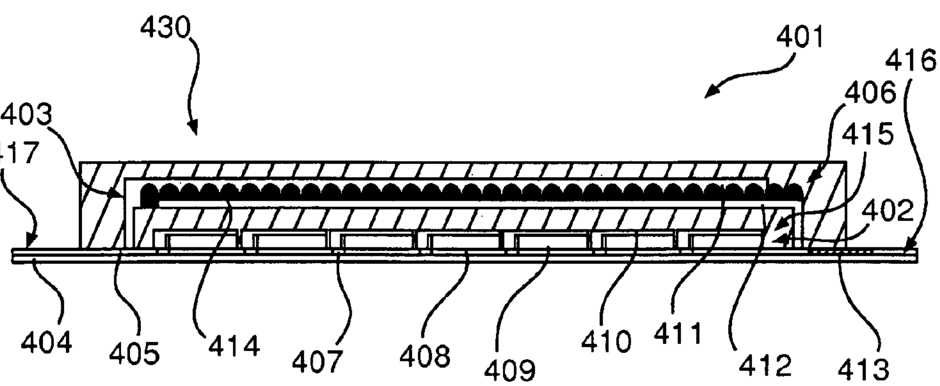

430
401
416
406
403
415
417
402
404
405
414
407
408
409
410
411
412
413

FIG. 11

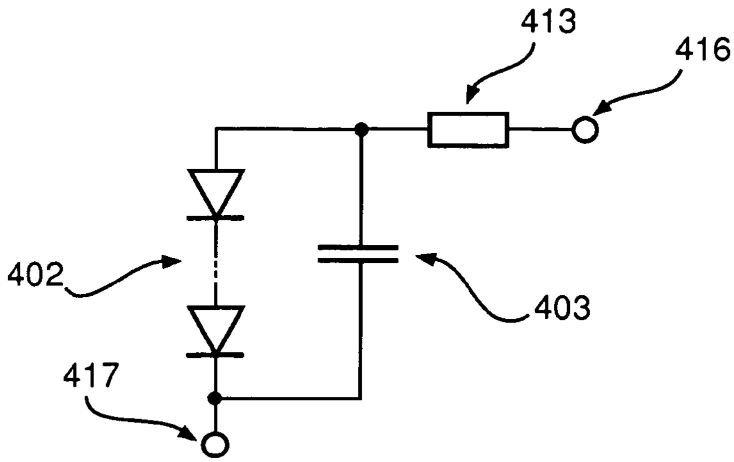


FIG. 12

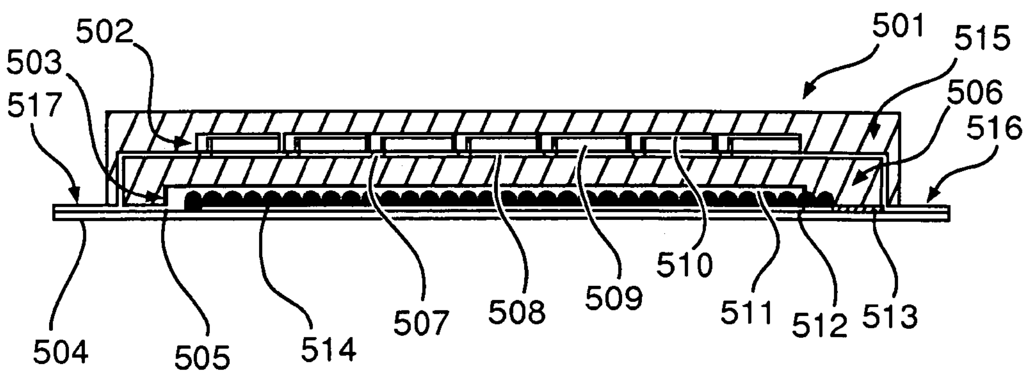


FIG. 13

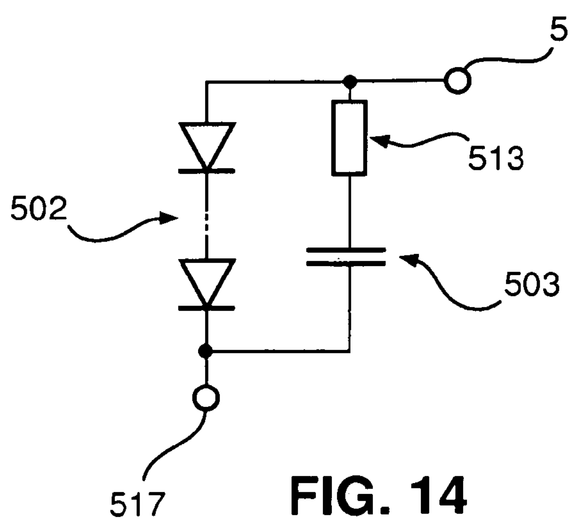


FIG. 14

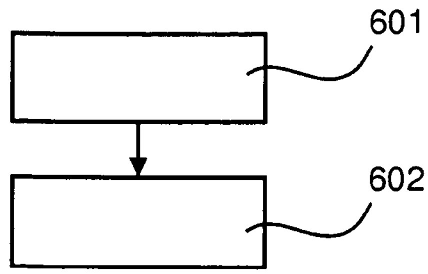


FIG. 15

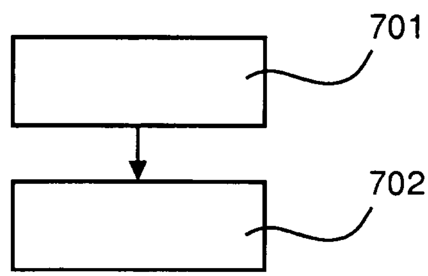


FIG. 16

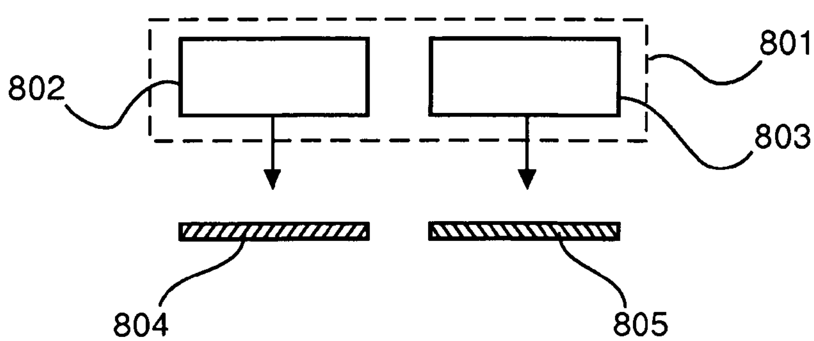


FIG. 17

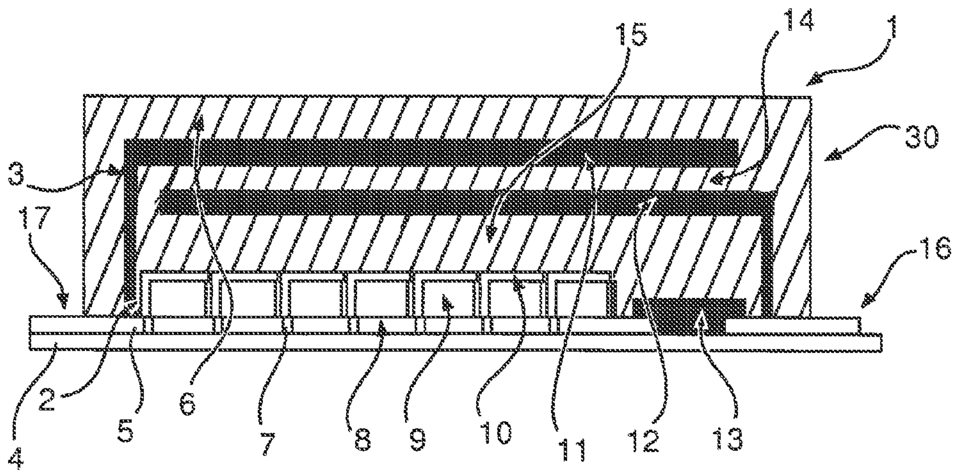


FIG. 18

LIGHT APPARATUS FOR GENERATING LIGHT

CROSS-REFERENCE TO PRIOR APPLICATIONS

This application is the U.S. National Phase application under 35 U.S.C. §371 of International Application No. PCT/IB2012/050470, filed on Jan. 18, 2013, which claims the benefit of U.S. Patent Application No. 61/593,887, filed on Feb. 2, 2012. These applications are hereby incorporated by reference herein.

FIELD OF THE INVENTION

The invention relates to a light apparatus and a light method for generating light. The invention relates further to a manufacturing apparatus and a manufacturing method for manufacturing the light apparatus.

BACKGROUND OF THE INVENTION

An organic light emitting diode (OLED) apparatus generally requires a converter for converting mains energy into a form as required by the OLED apparatus. The converting means comprises a capacitor for delivering energy during time phases, in which the mains voltage is lower than the voltage required by the OLED apparatus, in order to reduce perceptible light flicker that may be caused by a periodic temporal variation of the mains energy and the fast electrical time constant of the OLED apparatus. The capacitor is relatively bulky making the overall OLED apparatus relatively large.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a light apparatus for generating light, which can be less bulky. It is a further object of the present invention to provide a corresponding light method for generating light, and to provide a manufacturing apparatus and a manufacturing method for manufacturing the light apparatus.

In a first aspect of the present invention a light apparatus for generating light is presented, wherein the light apparatus comprises:

- a light emission structure including at least two light emission electrodes and a light emission material arranged between the light emission electrodes, wherein the light emission material is adapted, to emit light, if a voltage is applied to the light emission electrodes,
- a capacitor structure including at least two capacitor electrode films and a dielectric film between the capacitor electrode films, the capacitor structure being integrated in the light apparatus such that the capacitor electrode films and the dielectric film are at least partly arranged in parallel to the light emission structure, and
- a film encapsulation comprising at least one film, wherein the at least one film encapsulates at least the light emission material for protecting at least the light emission material.

Since the capacitor structure includes at least two capacitor electrode films and a dielectric film between the capacitor electrode films, the capacitor structure can be relatively thin. Moreover, since the encapsulation is a film encapsulation comprising at least one film for encapsulating at least the light emission material for protecting at least the light emission material preferentially against moisture and/or oxygen, also the film encapsulation can be relatively thin. For these reasons and since the relatively thin capacitor structure is integrated in the light apparatus such that the capacitor electrode films and the dielectric film are at least partly arranged in parallel to the light emission structure, the light apparatus can be less bulky.

That the capacitor electrode films and the dielectric film are at least partly arranged in parallel to the light emission structure preferentially means that the capacitor electrode films and the dielectric film can cover the whole area of the light emission structure or only a part of the light emission structure.

The capacitor structure can be integrated in the film encapsulation such that the capacitor structure is formed by films of the film encapsulation. In particular, films of the film encapsulation can form the capacitor electrode films and the dielectric film. This can further increase the compactness of the resulting light apparatus. Moreover, the capacitor structure and the film encapsulation can be manufactured by similar methods and, thus, by similar manufacturing elements, thereby simplifying the manufacturing of the light apparatus.

The film encapsulation with the integrated capacitor structure can be a thin film encapsulation (TFE), wherein the different films of the film encapsulation and, thus, the films of the capacitor structure can have a thickness of about 100 nm. Preferentially, the thin film encapsulation is configured such that a further protection against, for instance, moisture and oxygen, which may be provided by an additional glass plate or foil, is not needed and therefore preferentially not present.

The light apparatus is preferentially an OLED light apparatus, wherein the light emission material comprises organic material.

The term “light emission electrodes” is used for indicating that these electrodes are used for applying a voltage to the light emission material such that the light emission material emits light.

The capacitor electrode films are preferentially thin films having a thickness of about 100 nm. They can comprise metal and/or a transparent conductive oxide (TCO). The dielectric film is preferentially insulating. It preferentially comprises at least one of an oxide and a nitride. In particular, the dielectric film can comprise an anorganic oxide. For example, the dielectric film can comprise at least one of Al_2O_3, $AlTiO_x$ and ZrO_2. In an embodiment, the dielectric film is a nanolaminate, wherein it may comprise a changing order of Al_2O_3 and ZrO_2. The dielectric film may be deposited by atomic layer deposition (ALD).

The capacitor structure can be electrically connected to the light emission structure, or it can be electrically separated from the light emission structure, wherein the light emission structure and the capacitor structure are preferentially integrated in a single integrated unit emitting the light.

The film encapsulation preferentially comprises a first moisture and oxygen barrier for protecting the light emission structure against moisture and oxygen. The first moisture and oxygen layer is preferentially located between the light emission structure and the capacitor structure. In a preferred embodiment, the first moisture and oxygen barrier and the dielectric film are made of the same material. This allows producing the first moisture and oxygen barrier and the dielectric film by using the same or similar manufacturing units and manufacturing techniques, thereby simplifying the manufacturing of the light apparatus.

The film encapsulation preferentially further comprises a second moisture and oxygen barrier for protecting at least the capacitor structure against moisture and oxygen. Also the second moisture, and oxygen barrier and the dielectric film may be made of the same material, in particular, if the capacitor structure and the light emission structure are electrically connected.

Since the same material may be used for forming the dielectric film of the capacitor structure and for providing a protection against moisture and oxygen, also the moisture and oxygen barriers can be dielectric films, in particular, thin dielectric films of about 100 nm. In an embodiment, also the moisture and oxygen barriers are nanolaminates.

In a preferred embodiment, the light apparatus further comprises a resistor electrically connected to the light emitting structure and to the capacitor structure. The resistor may be a resistive layer arranged on the second moisture and oxygen layer.

It is preferred that the capacitor structure is adapted to influence the emitted light. In particular, the capacitor structure can be at least partly transparent to the emitted light, wherein the light apparatus is adapted such that the emitted light traverses at least a part of the transparent capacitor structure before leaving the light apparatus. For instance, the light apparatus can be a top emitting light apparatus having a top light emission electrode being at least partly transparent to the emitted light, wherein the capacitor structure is located on top of the light emission structure and wherein the capacitor structure is at least partly transparent to the emitted light for allowing the light to leave the light apparatus through the capacitor structure, whereby the capacitor structure influences the light. Moreover, the light apparatus can be a bottom emitting light apparatus having a bottom light emission electrode being at least partly transparent to the emitted light, wherein the light emission structure is located on top of the capacitor structure and wherein the capacitor structure is at least partly transparent to the emitted light for allowing the light to leave the light apparatus through the capacitor structure, whereby the capacitor structure influences the light. In a further example, the light apparatus is a top emitting light apparatus having a top light emission electrode being at least partly transparent to the emitted light, wherein the light emission structure is located on top of the capacitor structure, wherein a bottom capacitor electrode is adapted to reflect the emitted light towards the top of the light apparatus and wherein the capacitor structure is at least partly transparent to the emitted light above the bottom capacitor electrode. Thus, the outcoupling of the light can be influenced, without necessarily needing a further outcoupling structure. This can lead to a further reduction of the dimensions of the light apparatus.

In an embodiment, at least one of a) at least one of the capacitor electrode films and b) the dielectric film is structured for influencing the light. In particular, one or several capacitor electrode films and/or one or several dielectric films may not be plane. For instance, they can be curled, or they can consist of particles embedded in a matrix system.

The light apparatus can comprise a substrate coated with a conductive material forming a first one of the at least two light emission electrodes. The substrate can be a solid substrate like glass or a flexible substrate like a polymer foil. The coated conductive material is preferentially a TCO like indium tin oxide (ITO) or aluminum doped zinc oxide (AZO). The conductive material can be regarded as forming a ground light emission electrode of an OLED. On top of the ground light emission electrode the light emission material can be provided, on which a conductive material like metal or a TCO can be applied for forming the opposing light emission electrode.

In a further aspect of the present invention a light method for generating light by using the light apparatus is presented, wherein the light method comprises a) applying voltage to the light emission material arranged between the at least two light emission electrodes via the light emission electrodes, wherein the capacitor structure including the at least two capacitor electrode films and the dielectric film between the capacitor electrode films reduces possible fluctuations of the applied voltage, wherein the capacitor structure is integrated in the light apparatus such that the capacitor electrode films and the dielectric film are at least partly arranged in parallel to the light emission structure and wherein at least the light emission material is encapsulated by the at least one film for providing the film encapsulation protecting at least the light emission material, and b) emitting light by the light emission material in response to the applied voltage.

In a further aspect of the present invention a manufacturing method for manufacturing a light apparatus for generating light is presented, wherein the manufacturing method comprises a) providing a light emission structure including at least two light emission electrodes and a light emission material arranged between the light emission electrodes, wherein the light emission material is adapted to emit light, if a voltage is applied to the light emission electrodes, b) providing a capacitor structure including at least two capacitor electrode films and a dielectric film between the capacitor electrode films, wherein the capacitor structure is integrated in the light apparatus such that the capacitor electrode films and the dielectric film are at least partly arranged in parallel to the light emission structure, c) encapsulating at least the light emission material by at least one film for providing a film encapsulation protecting at least the light emission material. In an embodiment, steps b) and c) are performed in an integrated way, wherein with depositing films of the film encapsulating also films of the capacitor structure are deposited, in order to form a film encapsulation with an integrated capacitor structure. The dielectric film can be provided by at least one of the following techniques: ALD, plasma enhanced ALD, chemical vapor deposition (CVD), plasma enhanced CVD (PECVD), sputtering, phase vapor deposition (PVD).

In a further aspect of the present invention a manufacturing apparatus for manufacturing a light apparatus for generating light is presented, wherein the manufacturing apparatus comprises a) a light emission structure providing unit for providing a light emission structure including at least two light, emission electrodes and a light emission material arranged between the light emission electrodes, wherein the light emission material is adapted to emit light, if a voltage is applied to the light emission electrodes, b) a capacitor structure providing unit for providing a capacitor structure including at least two capacitor electrode films and a dielectric film between the capacitor electrode films, wherein the capacitor structure providing unit is adapted to integrate the capacitor structure in the light apparatus such that the capacitor electrode films and the dielectric film are at least partly arranged in parallel to the light emission structure, and c) a film encapsulation providing unit for providing a film encapsulation comprising at least one film for encapsulating at least the light emission material for protecting at least the light emission material. The capacitor structure providing unit and the film encapsulation providing unit can form a single integrated unit for providing an integrated capacitor structure and film encapsulation structure, wherein this integrated structure preferentially forms a thin film encapsulation for protecting at least the light emission material against, for instance, moisture and oxygen.

It shall be understood that the light apparatus of claim **1**, the light method of claim **12**, the manufacturing method of claim **13** and the manufacturing apparatus of claim **15** have similar and/or identical preferred embodiments, in particular, as defined in the dependent claims.

It shall be understood that a preferred embodiment of the invention can also be any combination of the dependent claims with the respective independent claim.

These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following drawings:

FIG. **1** shows schematically and exemplarily an embodiment of a light apparatus for generating light, wherein the light apparatus is a bottom-emitting light apparatus,

FIG. **2** shows schematically and exemplarily an equivalent circuit of the light apparatus shown in FIG. **1**,

FIG. **3** shows schematically and exemplarily a further embodiment of a bottom-emitting light apparatus, wherein a resistor is arranged on top of a capacitor structure,

FIG. **4** shows schematically and exemplarily an equivalent circuit of the light apparatus shown in FIG. **3**,

FIG. **5** shows a further embodiment of a bottom-emitting light apparatus, wherein the light apparatus comprises a capacitor structure having several capacitors,

FIG. **6** shows schematically and exemplarily an equivalent circuit of the light apparatus shown in FIG. **5**,

FIG. **7** shows schematically and exemplarily an embodiment of a one-stage mains driver utilizing the light apparatus shown in FIG. **5**,

FIG. **8** shows schematically and exemplarily a two-stage mains driver utilizing the light apparatus shown in FIG. **5**,

FIG. **9** shows a further embodiment of a bottom-emitting light apparatus, wherein the light apparatus comprises electrically separated light emission and capacitor structures,

FIG. **10** shows schematically and exemplarily an equivalent circuit of the light apparatus shown in FIG. **9**,

FIG. **11** shows a further embodiment of a light apparatus for generating light, wherein the light apparatus is a top-emitting light apparatus having a transparent capacitor structure,

FIG. **12** shows schematically and exemplarily an equivalent circuit of the light apparatus shown in FIG. **11**,

FIG. **13** shows schematically and exemplarily a further embodiment of a light apparatus for generating light, wherein the light apparatus is a bottom-emitting light apparatus comprising a transparent capacitor structure located below a light emission structure,

FIG. **14** shows schematically and exemplarily an equivalent circuit of the light apparatus shown in FIG. **13**,

FIG. **15** shows a flowchart exemplarily illustrating an embodiment of a light method for generating light,

FIG. **16** shows a flowchart exemplarily illustrating a manufacturing method for manufacturing a light apparatus for generating light,

FIG. **17** shows schematically and exemplarily an embodiment of a manufacturing apparatus for manufacturing a light apparatus for generating light, and

FIG. **18** shows schematically and exemplarily an embodiment of a capacitor structure formed by film encapsulation.

DETAILED DESCRIPTION OF EMBODIMENTS

FIG. **1** shows schematically and exemplarily a light apparatus **1** for generating light. The light apparatus **1** is, in this embodiment, an OLED light apparatus comprising a light emission structure **2**, a capacitor structure **3** and a film encapsulation **30**, wherein the capacitor structure **3** is integrated in the film encapsulation **30**. The light emission structure **2** includes several pairs of light emission electrodes **8**, **10**, wherein between the light emission electrodes **8**, **10** a light emission material **9** is arranged. The light emission material **9** is adapted to emit light, if a voltage is applied to the light emission electrodes **8**, **10**. The light emission material **9** comprises organic material emitting the light.

The capacitor structure **3** includes two capacitor electrode films **11**, **12** and a dielectric film **14** between the capacitor electrode films. The capacitor structure **3** is integrated in the light apparatus **1** such that the capacitor electrode films **11**, **12** and the dielectric film **14** are arranged in parallel to the light emission structure. The capacitor electrode films **11**, **12** and the dielectric film **14** are thin films having a thickness of about 100 nm. The capacitor electrode films can comprise metal and/or a transparent conductive oxide. The dielectric film is preferentially insulating and comprises at least one of an oxide or a nitride. In particular, the dielectric film **14** can comprise an anorganic oxide. For example, the dielectric film **14** can comprise at least one of Al_2O_3, $AlTiO_x$ and ZrO_2. It is preferentially a nano laminate comprising a changing order of different oxides and/or nitrides. For instance, the dielectric film **14** can comprise a changing order of Al_2O_3 and ZrO_2. The light emission structure **2** and the capacitor structure **3** are integrated in a single integrated unit emitting the light, wherein, in this embodiment, the light emission structure **2** and the capacitor structure **3**, are electrically connected.

The film encapsulation **30** is a thin film encapsulation comprising a first moisture and oxygen barrier **15** for protecting the light emission structure **2** against moisture and oxygen. The first moisture and oxygen barrier **15** is located between the light emission structure **2** and the capacitor structure **3**. The first moisture and oxygen barrier **15** and the dielectric film **14** between the capacitor electrode films **11**, **12** are made of the same material.

The film encapsulation **30**, i.e. in this embodiment the thin film encapsulation, further comprises a second moisture and oxygen barrier **6** for protecting at least the capacitor structure **3** against moisture and oxygen. In this embodiment, also the second moisture and oxygen barrier and the dielectric film are made of the same material. Thus, the same material can be used for forming the dielectric film **14** of the capacitor structure **3** and for providing a protection against moisture and oxygen. In particular, also the moisture and oxygen barriers can be dielectric films, in particular, thin dielectric films of about 100 nm, and they can also be nano laminates.

The light apparatus **1** further comprises a resistor **13** being, in this embodiment, a TCO resistor and being electrically connected to the light emitting structure **2** and to the capacitor structure **3**.

In the orientation shown in FIG. **1**, each pair of light emission electrodes consists of a bottom light emission electrode and a top light emission electrode. The light apparatus **1** comprises a substrate **4** coated with a structured conductive layer **5** being, in this embodiment, an ITO layer. The structured conductive layer **5** provides the bottom light emission electrodes **8**, which are separated by passive elements **7**, and contact pads **16**, **17** for contacting the light apparatus **1** to a voltage source. The top light emission electrodes **10** can comprise metal like silver or copper. The electrical circuit of the light apparatus **1** shown in FIG. **1** can be illustrated by the equivalent circuit schematically and exemplarily shown in FIG. **2**.

As can be seen in FIG. **2**, the pairs of top and bottom light emission electrodes are connected in series, thereby forming the light emission structure **2**. The resistor **13** is connected in series with the light emission structure **2** and the capacitor structure **3** is connected in parallel to the light emission structure **2**.

In this embodiment, the first moisture and oxygen barrier **15** is part of the thin film encapsulation **30** deposited on the light emission structure **2**. If during manufacturing the light apparatus **1** the thin film encapsulation **30** is deposited, this deposition of the thin film encapsulation is performed such that the bottom and top light emission electrodes **8**, **10** are still connectable by contacting corresponding contact pads **16**, **17**.

During manufacturing the light apparatus **1** on top of the first moisture and oxygen barrier **15** a conductive layer is deposited, which, can comprise, for instance, metal or a transparent conductive oxide and which forms the capacitor electrode film **12**. The deposition process can be, for instance, vacuum evaporation, sputtering, plasma enhanced laser deposition, or atomic layer deposition. The conductive layer **12** on the first moisture and oxygen barrier **15** contacts the top electrode contact pad **16** and forms a first plate of the capacitor structure **3**, i.e. forms a first capacitor electrode film, placed directly onto the first moisture and oxygen barrier **15**. The bottom electrode pads of the light emission structure **2** and the capacitor structure **3** are left unconnected, i.e. the pairs of light emission electrodes sandwiching a respective light emission material form OLEDs which are connected in series, wherein the respective bottom electrode **8** is connected with the top electrode of the respective neighboring OLED and wherein, for instance, the contact pad **17** is connected with the top electrode of the first OLED, but is still not connected with the capacitor structure **3** after the deposition of the first capacitor electrode film **12**.

On top of the conductive layer forming, in this embodiment, the bottom capacitor electrode film **12**, another thin film can be deposited for forming the dielectric film **14**, wherein the electrode ports, i.e. the contact pads **16**, **17**, are still kept uncoated for further connection with the additional capacitor plate, i.e. with the additional capacitor electrode film **11**.

Moreover, in this embodiment, a second conducting layer consisting of metal or a transparent conducting oxide, is deposited on the dielectric layer **14** for forming the top capacitor electrode film **11**. In other embodiments, the alternating deposition of a dielectric layer and a conducting layer can be performed several times, in order to generate a capacitor structure having a desired capacitance. Finally, the capacitor structure is protected by a final thin film forming the second moisture and oxygen barrier **6**.

Depending on the specific application, the OLEDs, i.e. the pairs of light emission electrodes sandwiching the respective light emission material, can be designed as bottom or top emitting light sources as well as transparent devices emitting in both directions. The several films above the light emission structure **2**, in particular, the films of the capacitor structure **3** and the moisture and oxygen barriers **15**, **16** form the film encapsulation **30** for encapsulating the light emission structure and the capacitor structure.

In the light apparatus **1** the thin film based capacitor structure **3** is integrated in the thin film encapsulation of the OLED stack, i.e. in the thin film encapsulation of the light emission structure **2**, in order to work as electric filter element. However, the capacitor structure can be adapted to influence the emitted light such that the capacitor structure does not only work as an electric filter, but does also have the function of concomitantly improving or at least modifying the light outcoupling.

In particular, the light apparatus **1** shown in FIG. **1** can be adapted such that it is a top emitting light apparatus, wherein the capacitor structure **3** is located on top of the light emission structure **2**, wherein the capacitor structure **3** is at least partly transparent to the emitted light for allowing the light to leave the light apparatus **1** through the capacitor structure **3**, whereby the capacitor structure influences the light. In this case the top light emission electrodes are at least partly transparent to the emitted light and the bottom light emission electrodes are opaque. Thus, the light apparatus **1** shown in FIG. **1** can comprise top emitting OLEDs connected in series and comprising an opaque bottom light emission electrode **8**, a multilayer OLED stack consisting of organic and inorganic materials forming the light emission material **9**, and a transparent top light emission electrode **10**, which may be completely transparent or semi-transparent. The OLEDs are connected with a thin film based resistor **13** in series and are encapsulated by the thin film **15** being, in this'embodiment, transparent. On top of this thin film **15** forming the moisture and oxygen barrier, in this embodiment, a transparent thin film based capacitor forming the capacitor structure **3** is deposited. Alternatively, the capacitor structure can be segmented in two sub-units, which can be connected in parallel or in series to increase the capacitance or breakdown voltage, respectively. The capacitor structure **3** consists of the dielectric film **14** and the capacitor electrode films **11**, **12**, wherein, in this example, the dielectric film **14** is transparent and also the capacitor electrode films are semi-transparent or completely transparent as realized by transparent conductive oxides or multilayer electrodes with ultra thin metal layers, in order to have an impact on the optical characteristics of the OLEDs. In this example, also the thin film **6** on top of the capacitor structure **3** is transparent. The respective effect on the light emission depends on both, the OLED stack, i.e. the light emission structure **2**, and the thin film encapsulation **30** with the integrated capacitor structure **3** and can be attributed to micro-cavity and wave-guiding effects. The same holds true for transparent OLED devices realized by making the bottom light emission electrode transparent like the top light emission electrode. In this case, the thin film based capacitor structure **3** determines the fraction of light emitted through the top light emission electrode compared to the light emitted through the bottom light emission electrode. The light emission can therefore be directed to a certain extent into one half-space of the transparent device.

FIG. **3** shows schematically and exemplarily a further embodiment of a light apparatus. The light apparatus **101** shown in FIG. **3** is similar to the light apparatus **1** shown in FIG. **1**, except for the resistor. Thus, also the light apparatus **101** comprises a substrate **104** coated with an ITO layer **105**, which is structured to form the bottom light emission electrodes **108**. Moreover, also the light apparatus **101** comprises top light emission electrodes **110**, light emission material **109**, passive elements **107**, a first moisture and oxygen barrier **115**, a capacitor structure **103** with capacitor plates, i.e. capacitor electrode films, **111**, **112** and a dielectric film **114**, and a second moisture and oxygen barrier **106**. However, on top of the second moisture and oxygen barrier **106** resistive layers **113** are provided, which are covered by a third moisture and oxygen barrier **119**, which is preferentially also a thin film comprising the dielectric material for protecting against moisture and oxygen. The resistor **113** can be a transparent conductive oxide resistor, which can be electrically connected via a contact pad **118**.

FIG. **4** shows schematically and exemplarily an equivalent circuit of the light apparatus **101** shown in FIG. **3**. As can be seen in FIG. **4**, the light emission structure **102** is parallel to the capacitor structure **103** and the resistor **113** is in series with the light emission structure **102** and the capacitor structure **103**, wherein the light apparatus **101** can be contacted via contact pads **117**, **118**.

Thus, onto the thin film **106**, another conductive but resistive material is deposited to act as a charging resistor for the parallel circuit of the OLEDs, i.e. of the light emission structure **102**, and the capacitor structure **103**. Therefore, the charging resistor **113** is connected to an extra port, i.e. to the resistor contact pad **118**, not belonging to the rest of the whole circuit. The combination of the charging resistor **113** in series circuit with the parallel circuit of the light emission structure **102** and the capacitor structure **103** generates a low-pass filter to smooth signals coming to the parallel circuit. By choice of material and resistive material thickness, the charging resistor **113** can be set up as desired. Such kind of low pass filter is preferentially used, for example, for OLEDs, which are designed for a direct mains connection utilizing resistive ballast. In addition to the third oxygen and moisture barrier **119** being a gas protection provided by the thin film, the light apparatus can further be covered by, for instance, a scratch protection made of, for example, an epoxy compound (not shown in FIG. **3**). The capacitor structure **103**, the oxygen and moisture barriers **115**, **106**, **119** and the resistor **113** form a film encapsulation **130**, in particular, a thin film encapsulation, for protecting the light emission structure **102** against moisture and oxygen, wherein the capacitor structure **103** and the resistor **113** are integrated into the film encapsulation **130**.

FIG. **5** shows schematically and exemplarily a further embodiment of a light apparatus. The light apparatus **201** shown in FIG. **5** is similar to the light apparatus **1** shown in FIG. **1**, except for the capacitor structure **203** and the missing additional resistor. In particular, the light apparatus **201** comprises a substrate **204** precoated with a structured ITO layer **205** forming the bottom light emission electrodes **208**. Moreover, also the light apparatus **201** comprises passive elements **207**, top light emission electrodes **210**, light emission materials **209**, respectively sandwiched between pairs of bottom and top light emission electrodes **208**, **210**, wherein each light emission electrodes pair with the respective sandwiched light emission material can be regarded as forming an OLED, first and second moisture and oxygen barriers, **215**, **206**, and contact pads **220**, **221**, **222** for contacting the light apparatus to a voltage source. In this embodiment, the capacitor structure **203** comprises more than two capacitor electrode films **211**, **212**, **223**, **224**, which can also be regarded as being capacitor plates, wherein between these capacitor electrode films a dielectric film **214** is provided. The capacitor structure **203** is integrated in the light apparatus **201** such that the capacitor electrode films **211**, **212**, **223**, **224** and the dielectric film **214** are arranged in parallel to the light emission structure **202**. The conducting layers forming the capacitor plates may consist either of metals such as aluminium or silver or of transparent conductive oxides such as ITO or AZO, respectively. These conducting layers are deposited in such a way that they have electrical contact to the top light emission electrode ground. The ground light emission electrode contact pad **220** of the light emission structure **202** and the capacitor contact pad **221** are kept unconnected. In particular, in a three-dimensional drawing it would be visible that the connector **220** is not completely coated by the moisture and oxygen barrier **215** such that the connector **220** is still connectable. The dielectric layers are deposited such that they isolate the conducting capacitor plates **211**, **212**, **223**, **224**. The capacitor structure **203** and the moisture and oxygen barriers **215**, **206** form a film encapsulation **230**, in particular, a thin film encapsulation, wherein the capacitor structure **203** is integrated into the film encapsulation **230**. FIG. **6** shows schematically and exemplarily an equivalent circuit of the light apparatus **201**. As can be seen, the capacitor structure **203** is parallel to the light emission structure **202**.

The light apparatus can be utilized by, for example, a one-stage offline driver or a two-stage offline driver, where the light apparatus can replace the need for an extra capacitor component for, for instance, flicker reduction. The utilization of the light apparatus **201** in a one-stage offline driver is schematically and exemplarily shown in FIG. **7**.

In FIG. **7**, mains **32** are connected with a bridge rectifier **31** and a converter **30**, in order to apply a relatively constant current to the light apparatus **201**. FIG. **8** shows schematically and exemplarily the utilization of the light apparatus **201** in a two-stage offline driver.

In FIG. **8**, mains **32** are connected to a bridge rectifier **31**, a pre-conditioner **34** and a second stage **33**. The pre-conditioner **34** is used to reduce the power factor of the power supply, in order to read power factor limitations based on existing and upcoming national rulings in various markets like EN 61000-3-2 or the Energy Star specifications.

FIG. **9** shows schematically and exemplarily a further embodiment of a light apparatus. The light apparatus **301** shown in FIG. **9** also comprises a substrate **304** coated with a structured ITO layer **305** for forming bottom light emission electrodes **308** separated by passive elements **307**, wherein each bottom light emission electrode **308** forms together with a corresponding top light emission electrode **310** and light emission material **309** located between the respective bottom and top light emission electrodes **308**, **310** an OLED and wherein the resulting series of OLEDs forms a light emission structure **302**. This light emission structure **302** is covered by a moisture and oxygen barrier **315**, wherein on top of the moisture and oxygen barrier **315** a capacitor structure **303** is provided. The capacitor structure **303** comprises capacitor electrode films **311**, **312**, which may also be regarded as being capacitor plates, and a dielectric film **314** arranged partly between the capacitor electrode films **311**, **312**. Also in this embodiment the capacitor structure **303** is integrated in the light apparatus **301** such that the capacitor electrode films **311**, **312** and the dielectric film **314** are arranged in parallel to the light emission structure **302**. The light apparatus **301** further comprises two contact pads **322**, **320** for contacting the top and bottom light emission electrodes **310**, **308**, and capacitor contact pads **316**, **317** for contacting the capacitor structure **303**. The capacitor structure **303** is located on top of the encapsulation provided by the moisture and oxygen barrier **315**, but electrically isolated. In this embodiment, the dielectric material forming the dielectric film **314** of the capacitor structure **303** can consist of any insulating material and can be different to the thin film encapsulation material used for providing the moisture and oxygen barrier **315**. The capacitor structure **303** forms together with the moisture and oxygen barrier **315** a film encapsulation **330** for protecting the light emission structure **302** against moisture.

FIG. **10** shows schematically and exemplarily an equivalent circuit of the light apparatus **301** shown in FIG. **9**. In particular, FIG. **10** illustrates that the circuit of the light emission structure **302** and of the capacitor structure **303** are electrically isolated.

FIG. **11** shows schematically and exemplarily a further embodiment of a light apparatus. The light apparatus **401** shown in FIG. **11** comprises a substrate **404** coated with a transparent conductive oxide **405**, wherein the transparent conductive oxide **405** is structured for forming bottom light emission electrodes **408**, which are separated by passive elements **407**. Pairs of the bottom light emission electrodes **408** and top light emission electrodes **410** are provided, wherein each pair of these light emission electrodes **408**, **410** sandwiches light emission material **409** for forming an OLED. Thus, several OLEDs are formed, which are electrically connected in series, thereby forming a light emission structure **402**. The light emission structure **402** is covered by a moisture and oxygen barrier **415**, and on top of the moisture and oxygen barrier **415** a capacitor structure **403** is provided. The capacitor structure **403** is encapsulated by a further, second moisture and oxygen barrier **406**. The capacitor structure **403** comprises two capacitor electrode films **411**, **412**, which may also be regarded as being capacitor plates, and a dielectric film **414** between the capacitor electrode films **411**, **412**. The capacitor structure **403** is integrated in the light apparatus **401** such that the capacitor electrode films **411**, **412** and the dielectric film **414** are arranged in parallel to the light emission structure **402**. The light apparatus **401** further comprises a transparent conductive oxide resistor **413** and contact pads **416**, **417**. The dielectric film **414** is structured for influencing the light. For example, it can be curled or it can consist of particles embedded in a matrix system.

The light apparatus **401** shown in FIG. **11** is similar to the top emitting light apparatus described above with reference to FIG. **1**, except for the circuitry and the design of the dielectric. The circuitry differs in that the optional resistor **413** is connected in series with the whole circuitry of the light emission structure **402** and the capacitor structure **403** as schematically and exemplarily illustrated in the equivalent circuit shown in FIG. **12**. Moreover, the dielectric is not plane any more such that in an integrated solution a thin film based capacitor structure **403** is used as electric filter and also influences the optical characteristics of the outcoupling of the light out of the light, apparatus **401**. Depending on the respective form of the dielectric film **414**, light scattering and/or specific properties of a distributed bragg reflector can be favored, in order to modify the outcoupling efficiency or angular-dependent characteristics of the light emission as already realized in external outcoupling structures of known OLEDs. At the same time, the thickness and form of the dielectric film **414** has an impact on the dimension of the capacitor structure **403**. A smaller thickness leads to a higher capacitance, but to lower breakdown voltages following the simplified picture of a parallel plate capacitor. The form of the dielectric film **414** also determines the capacitance density, because a curled dielectric film together with plane or curled capacitor electrode films lead to a larger surface compared to a parallel plate capacitor. The capacitor structure **403** and the further layers above the light emission structure **402** like the moisture and oxygen barriers **415**, **406** form a film encapsulation **430** for encapsulating the light emission structure **402** against moisture. Also in this embodiment the capacitor structure **403** is integrated into the film encapsulation **430**.

FIG. **13** shows schematically and exemplarily a further embodiment of a light apparatus. The light apparatus **501** shown in FIG. **13** comprises a substrate **504** coated with a transparent conductive oxide **505** forming a bottom capacitor electrode film **512**. On the capacitor electrode film **512** a dielectric film **514** is provided, wherein the dielectric film **514** is structured, for instance, curled. On top of the dielectric film **514** a conductive layer **511** is provided forming a top capacitor electrode film. The capacitor electrode films **511**, **512** and the dielectric film **514** form a capacitor structure **503**. The capacitor structure **503** is encapsulated by a moisture and oxygen barrier **506** and on top of the moisture and oxygen barrier **506** a light emission structure **502** is provided. The light emission structure **502** in turn is also covered by a moisture and oxygen barrier **515**, which can be regarded as being a film encapsulation. The light emission structure **502** comprises pairs of bottom light emission electrodes **508** and top light emission electrodes **510** sandwiching light emission material **509**. Each pair of light emission electrodes and sandwiched light emission material forms an OLED, wherein the OLEDs are connected in series. Also in this embodiment the capacitor structure **503** is integrated in the light apparatus **501** such that the capacitor electrode films **511**, **512** and the dielectric film **514** are arranged in parallel to the light emission structure **502**.

The light apparatus **501** is a bottom emitting light apparatus, wherein the light emission structure **502** is located on top of the capacitor structure **503**, wherein the capacitor structure **503** is at least partly transparent to the emitted light for allowing the light to leave the light apparatus **501** through the capacitor structure **503**, whereby the capacitor structure **503** influences the light and wherein the bottom light emission electrodes **508** are at least partly transparent to the emitted light. The top light emission electrodes **510** are opaque.

In FIG. **13**, the thin film based capacitor structure **503** is deposited directly on the transparent substrate **504** and is encapsulated by a thin film **506** forming an oxygen and moisture barrier. On this film **506** the structured bottom light emission electrodes **508** with elements of passive lacquer, i.e. passive elements **507**, defining active areas of the OLEDs can be precoated independently from the actual OLED process. Consequently, such precoated substrates could simplify the processing of the OLED devices with less effort and less stress applied on the organic material of the OLED stack forming the light emission material **509**. Hence, a transparent OLED light apparatus with a thin film based capacitor structure can be processed either with a capacitor structure deposited on top of the light emission structure as indicated, for instance, in FIG. **1** or the other way around as indicated, for instance, in FIG. **13**. The resistor **513** being a transparent conductive oxide resistor is connected in series with the capacitor structure **503** as schematically and exemplarily indicated in the equivalent circuit shown in FIG. **14**. In FIGS. **13** and **14** reference numbers **516**, **517** indicate contact pads for contacting the light apparatus.

In a further embodiment, the light apparatus shown in FIG. **13** comprises a reflective bottom capacitor electrode film, wherein the elements above the bottom capacitor electrode film are at least partly transparent to the emitted light. Thus, the light apparatus can be a top emitting light apparatus, wherein the light emission structure is located on top of the capacitor structure, wherein a bottom capacitor electrode film is adapted to reflect the emitted light towards the top of the light apparatus, wherein the capacitor structure is at least partly transparent to the emitted light above the bottom capacitor electrode film and wherein the light emission electrodes are at least partly transparent to the emitted light. The idea of substrates precoated with a thin film based capacitor structure can therefore also be applied to top emitting OLEDs by using an opaque metal electrode for the bottom contact of the capacitor structure.

Since the outcoupling structure, namely the capacitor structure, is embedded within a microcavity structure formed by all the layers together beginning from the bottom capacitor electrode film and ending by the outer thin film of the light apparatus on the top, the light outcoupling will be significantly influenced by the capacitor structure, in particular, by the thickness and the design of the dielectric film of the capacitor structure.

In the following a light method for generating light by using at least one of the above described light apparatuses will exemplarily be described with reference to a flowchart shown in FIG. **15**.

In step **601**, a voltage is applied to light emission material between at least two light emission electrodes via the light emission electrodes, wherein a capacitor structure including at least two capacitor electrode films and a dielectric film between the capacitor electrode films reduces possible fluctuations of the applied voltage, wherein the capacitor structure is integrated in the light apparatus such that the capacitor electrode films and the dielectric film are at least partly arranged in parallel to the light emission structure and wherein at least the light emission material is encapsulated by at least one film for providing a film encapsulation protecting at least the light emission material.

In step **602**, light is emitted by the light emission material in response to the applied voltage.

In the following a manufacturing method for manufacturing a light apparatus for generating light will exemplarily be described with reference to the flowchart shown in FIG. **16** and with reference to a manufacturing apparatus schematically and exemplarily shown in FIG. **17**.

The manufacturing apparatus **801** comprises a light emission structure providing unit **802** for providing a light emission structure including at least two light emission electrodes and a light emission material arranged between the light emission electrodes, wherein the light emission material is adapted to emit light, if a voltage is applied to the light emission electrodes. Thus, in step **701** the light emission structure providing unit **802** provides the light emission material and the top light emission electrodes on a substrate coated with a conductive layer forming the bottom light emission electrodes for forming the light emission electrode pairs sandwiching the respective light emission material, thereby generating a series of light emitting diodes, in particular, of OLEDs. The resulting intermediate product is indicated by reference number **804**. In step **702**, a film encapsulation and capacitor structure providing unit **803** deposits several thin films on the light emission structure, in order to provide a film encapsulation with an integrated capacitor structure such that the capacitor structure is formed by films, in particular, thin films, of the film encapsulation. The capacitor structure is provided in a way that it is integrated in the light apparatus such that capacitor electrode films and a dielectric film between the capacitor electrode films are at least partly arranged in parallel to the light emission structure. The resulting light apparatus is indicated by reference number **805** in FIG. **17**.

Manufacturing steps like the deposition of certain layers performed by one or several units or devices can be performed by any other number of units or devices. For example, steps **701** and **702** can be performed by a single unit or by any other number of different units, or the deposition of the several films for forming the film encapsulation and the capacitor structure, wherein the capacitor structure is preferentially integrated in the film encapsulation, can be performed by different units or devices depositing the different films. The control of the manufacturing apparatus in accordance with the manufacturing method can be implemented as program code means of a computer program and/or as dedicated hardware.

The embodiments of the light apparatuses described above with reference to the figures comprise a combination of OLEDs on a substrate, thin film encapsulation of OLEDs and thin film based capacitors and optionally resistors, wherein the thin film based capacitors and optionally the resistors may be integrated with the thin film encapsulation. A thin film as a moisture and oxygen barrier is preferentially used as a first dielectric on the top contacts of the OLEDs followed by a capacitor plate, i.e. followed by a capacitor electrode film, wherein preferentially the same material is used for the dielectric of the capacitor structure and the thin film moisture and oxygen barrier as exemplarily shown in FIG. **18**.

The embodiments of the light apparatus described above with reference to the figures allow to replace a bulky capacitor, which may be used for filter and/or storage purposes, in known light apparatuses. The embodiments allow saving costs and maintaining the form factor of OLED devices, i.e, they allow creating thin driver solutions. Preferentially, additional components, functional organic light emitting layers and/or additional thin film substrates are not required. The light apparatus can comprise a single OLED or a series or parallel circuit of OLEDs deposited onto a solid substrate like glass or a flexible substrate like a polymer foil, which is precoated with a transparent conductive oxide. The transparent conductive oxide can be, for instance, ITO or AZO as bottom light emission electrode for the respective OLED and as conducting material for further connections.

The OLEDs pixel shape is defined by a passivation lacquer forming passive elements. The OLED circuit, i.e. the light emission structure, is protected against atmospheric components such as moisture and oxygen by the moisture and oxygen barrier. The moisture and oxygen barrier can be provided by thin film layers consisting of, for instance, Al_2O_3 and ZrO_2, called nanolaminate. The same thin film layers can be used as dielectric film of the capacitor structure. Thus, the nano laminate, Al_2O_3 or another dielectric material can be used as a dielectric for the capacitor structure and as an encapsulation layer to protect the light emission structure against moisture and oxygen.

In above described embodiments the light apparatus provides an integration of thin film based capacitors together with thin film based resistors in thin film encapsulated devices like OLEDs. The capacitor and/or resistor structures can be integrated on top of or beneath the thin film encapsulated device, i.e. on top or beneath the light emission structure with the moisture and oxygen barrier. The integration can be related to one or several capacitors and/or resistors, which can be connected with each other and with the thin film encapsulated device to arbitrary circuits.

The thin films, in particular, the thin films used as protection against moisture and oxygen, can consist of a neat layer of oxide or nitride like Al_2O_3, ZrO_2, TiO_2, SiO_2, SiN, et cetera or a combination of them as nanolaminates. The encapsulation preferentially acts as electrical insulator and protects the encapsulated device against moisture and oxygen. The thin film encapsulation can be processed by ALD, PALD, CVD, PECVD, sputtering and other PVD techniques. The dielectric, i.e. the dielectric film, of the capacitor structure can consist of a neat layer of oxide or nitride or organic like Al_2O_3, ZrO_2, TiO_2, SiO_2, SiN, pentacen, et cetera or a combination of them exhibiting a high permittivity, a high breakdown voltage and a compact layer structure. Also the dielectric can be obtained by ALD, PALD, CVD, PECVD, sputtering and other PVD techniques. The dielectric can also be obtained by thermal evaporation spin-coating and other printing methods. For the benefit of a lower complexity, the dielectric and the thin film encapsulation can be obtained by using the same method and by using the same material system.

Moreover, in above described embodiments the light apparatus comprises a combination of thin film encapsulated OLEDs on a substrate with a thin film based capacitor structure and optionally resistors as electric filter elements and as outcoupling structures. Particularly, the usage of the thin film based capacitor structure as integrated outcoupling structure reduces the size of the light apparatus. Moreover, using a specifically structured material as dielectric of the capacitor structure increases the capacitance and concomitantly modifies the light emission characteristics of the light apparatus. Thus, the capacitor structure can function as electric filter element reducing the perceptible light modulation, i.e. reducing flickering, and modifying the outcoupling efficiency and angular-dependent characteristics, thereby maintaining minimum space requirements and thin form factors. In particular, since a thin film based capacitor structure is integrated into OLED devices, bulky filter elements of prior art OLED devices can be substituted and the functionality of the capacitor structure can be upgraded by arranging the capacitor structure on top or below the light emission structure, wherein transparent, in particular, semi-transparent, electrodes can be used for the capacitor structure and wherein the thicknesses of these capacitor electrodes, the thickness of the dielectric layer, the thickness of the OLED stack, i.e. the thickness of the light emission material, the thickness of the light emission electrodes and/or the thickness of the thin film encapsulation can be adjusted to influence the microcavity structure determining the properties of the outcoupling of the light as desired. The light apparatus does therefore not necessarily need additional outcoupling structures; thereby reducing the efforts for manufacturing the OLED devices and thereby allowing for a thin form factor of OLED solutions.

The capacitor structure can comprise several capacitors deposited onto each other to increase the capacitance or the breakdown voltage, and, concomitantly, to act as out-coupling structures. The capacitor structure can exhibit two transparent electrodes or one transparent and one opaque and reflecting metal electrode depending on the design of the OLEDs as bottom or top emitter or as transparent devices. The transparent electrodes of the capacitor can be transparent electrode films comprising transparent conductive oxides like ITO, AZO, et cetera, multilayer electrodes with ultra thin metal films like ITO/Ag/ITO, ZTO/AL/CTO, et cetera, semi-transparent thin metal films like Ag, Au, Al, et cetera, or a combination of these materials. The dielectric film and the electrode films of the capacitor can be plane or curled and the dielectric film can be homogeneous or can consist of particles embedded in a matrix system. The dielectric of the capacitor structure can be made of transparent oxides or nitrides realizing a high permittivity, a high breakdown voltage and a compact layer structure with impact on light outcoupling. In particular, it can be made of Al_2O_3, SiO_2, TiO_2, TaO, other oxides or nanolaminates of these materials like Al_2O_3/TiO_2. Alternatively or in addition, the dielectric can comprise organic materials, like polymers embedding oxide particles like TiO_2 and CeO_2 for light scattering. The polymers can be high-index polymers. The dielectric can also comprise organic small molecules.

The thin film encapsulation can be separately processed on top of the light emission structure and on top of the capacitor structure and/or the resistor. The dielectric and the transparent electrodes can be obtained by ALD, PALD, CVD, PECVD, sputtering and other PVD techniques as well as by thermal evaporation, spin-coating, other printing methods and a combination of these techniques.

Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims.

In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality.

A single unit or device may fulfill the functions of several items recited in the claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

A computer program may be stored/distributed on a suitable medium, such as an optical storage medium or a solid-state medium, supplied together with or as part of other hardware, but may also be distributed in other forms, such as via the Internet or other wired or wireless telecommunication systems.

Any reference signs in the claims should not be construed as limiting the scope.

The invention relates to a light apparatus for generating light. The light apparatus comprises a light emission structure including light emission material, a capacitor structure including at least two capacitor electrode films and a dielectric film between the capacitor electrode films, and a film encapsulation including at least one film for encapsulating and thereby protecting at least the light emission material. The capacitor structure is integrated in the light apparatus such that the capacitor electrode films and the dielectric film are at least partly arranged in parallel to the light emission structure. Since films, in particular, thin films, are used for the capacitor structure and the encapsulation and since the capacitor structure is integrated in the light apparatus, the light apparatus can be relatively thin.

The invention claimed is:

1. A light apparatus for generating light, the light apparatus comprising:

a light emission structure including at least two light emission electrodes and a light emission material arranged between the light emission electrodes, wherein the light emission material is arranged to emit an emitted light, if a voltage is applied to the light emission electrodes,

a capacitor structure including at least two capacitor electrode films and a dielectric film between the capacitor electrode films wherein the capacitor electrode films and the dielectric film are at least partly in parallel to the light emission structure, and

a film encapsulation comprising at least one film,

wherein the at least one film encapsulates at least the light emission material,

wherein at least a portion of the capacitor structure is formed by the film encapsulation.

2. The light apparatus as defined in claim **1**, wherein the dielectric film comprises an oxide.

3. The light apparatus as defined in claim **1**, wherein the film encapsulation comprises a first moisture and oxygen barrier.

4. The light apparatus as defined in claim **3**, wherein the first moisture and oxygen barrier and the dielectric film are made of the same material.

5. The light apparatus as defined in claim **1**, wherein the film encapsulation further comprises a second moisture and oxygen barrier.

6. The light apparatus as defined in claim **5**, wherein the second moisture and oxygen barrier and the dielectric film comprise the same material.

7. The light apparatus as defined in claim **1**, wherein the light apparatus further comprises a resistor electrically connected to the light emitting structure and to the capacitor structure.

8. The light apparatus as defined in claim **1**, wherein the capacitor structure is arranged to influence the emitted light.

9. The light apparatus as defined in claim **8**, wherein the capacitor structure is partly transparent to the emitted light and wherein the light apparatus is arranged such that the emitted light strikes at least a part of the transparent capacitor structure before leaving the light apparatus.

10. The light apparatus as defined in claim **8**, wherein at least one of the capacitor electrode films is arranged to influence the emitted light.

11. The light apparatus as defined in claim **1**, wherein the dielectric film comprises a nitride.

12. The light apparatus as defined in claim **8**, wherein the dielectric film is arranged to influence the emitted light.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,312,314 B2
APPLICATION NO. : 14/373369
DATED : April 12, 2016
INVENTOR(S) : Dirk Hente et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In The Specification

In column 1, line 8, delete “PCT/IB2012/050470” and replace with --PCT/IB2013/050470--.

Signed and Sealed this
Twenty-ninth Day of November, 2016

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office